LOE Ultrasonic Level Sensors
User Manual

Web Enabled Controller

APG®

Doc #9004258
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Introduction

Thank you for purchasing an LOE Ultrasonic Level Sensor and Web Enabled Controller from APG. We appreciate your business! Please take a few minutes to familiarize yourself with your LOE and this manual.

The LOE Ultrasonic Level Sensor and Web Enabled Controller offers a wide degree of integrated, flexible, remote and local control and monitoring for your system. The LOE can control up to 10 APG Modbus sensors--any combination of level, pressure, magnetostrictive and ultrasonic--and two output relay terminals. All readings are available for control and monitoring via TCP/IP for local or remote network access. The LOE also had flexible power options: it can use either POE or an independent 12-28 VDC power source.

Reading your label

Every APG controller comes with a label that includes the controller's model number, part number, and serial number. The LOE label also indicates the default IP address, subnet mask, and mac address. Please ensure that the model number on your label matches your order.

Warranty and Warranty Restrictions

APG warrants its products to be free from defects of material and workmanship and will, without charge, replace or repair any equipment found defective upon inspection at its factory, provided the equipment has been returned, transportation prepaid, within 24 months from date of shipment from factory.

THE FOREGOING WARRANTY IS IN LIEU OF AND EXCLUDES ALL OTHER WARRANTIES NOT EXPRESSLY SET FORTH HEREIN, WHETHER EXPRESSED OR IMPLIED BY OPERATION OF LAW OR OTHERWISE INCLUDING BUT NOT LIMITED TO ANY IMPLIED WARRANTIES OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE.

No representation or warranty, express or implied, made by any sales representative, distributor, or other agent or representative of APG which is not specifically set forth herein shall be binding upon APG. APG shall not be liable for any incidental or consequential damages, losses or expenses directly or indirectly arising from the sale, handling, improper application or use of the goods or from any other cause relating thereto and APG's liability hereunder, in any case, is expressly limited to the repair or replacement (at APG's option) of goods.

Warranty is specifically at the factory. Any on site service will be provided at the sole expense of the Purchaser at standard field service rates.

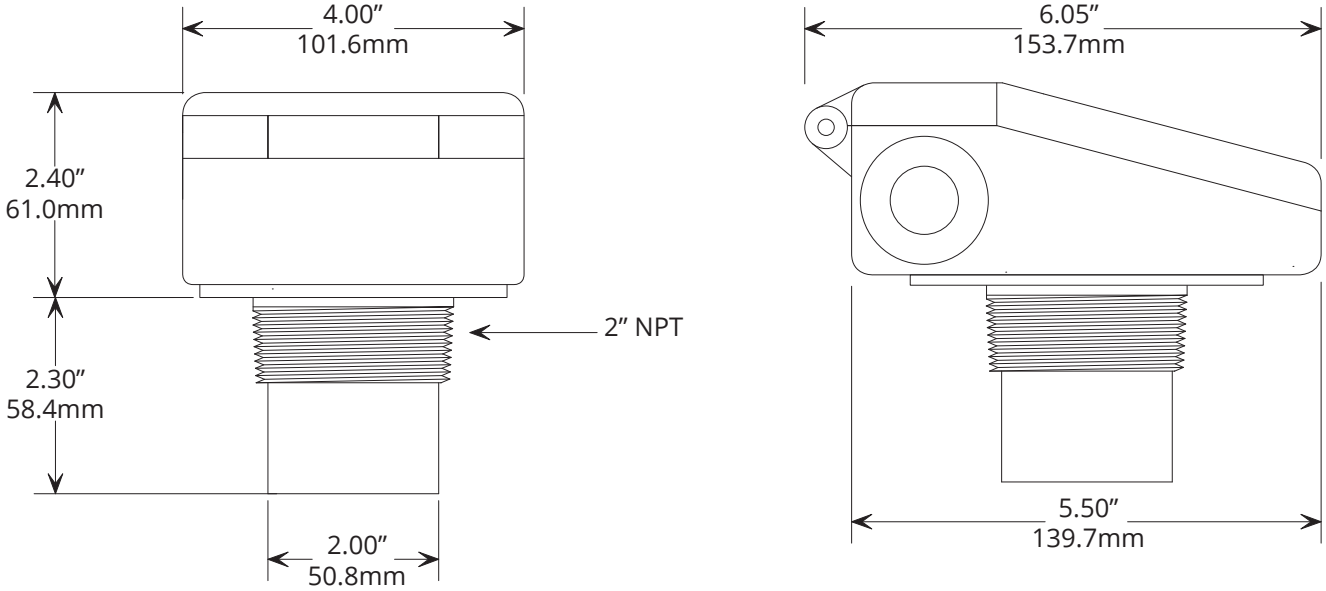
All associated equipment must be protected by properly rated electronic/electrical protection devices. APG shall not be liable for any damage due to improper engineering or installation by the Purchaser or third parties. Proper installation, operation and maintenance of the product becomes the responsibility of the user upon receipt of the product.

Returns and allowances must be authorized by APG in advance. APG will assign a Return Material Authorization (RMA) number which must appear on all related papers and the outside of the shipping carton. All returns are subject to the final review by APG. Returns are subject to restocking charges as determined by APG's "Credit Return Policy".

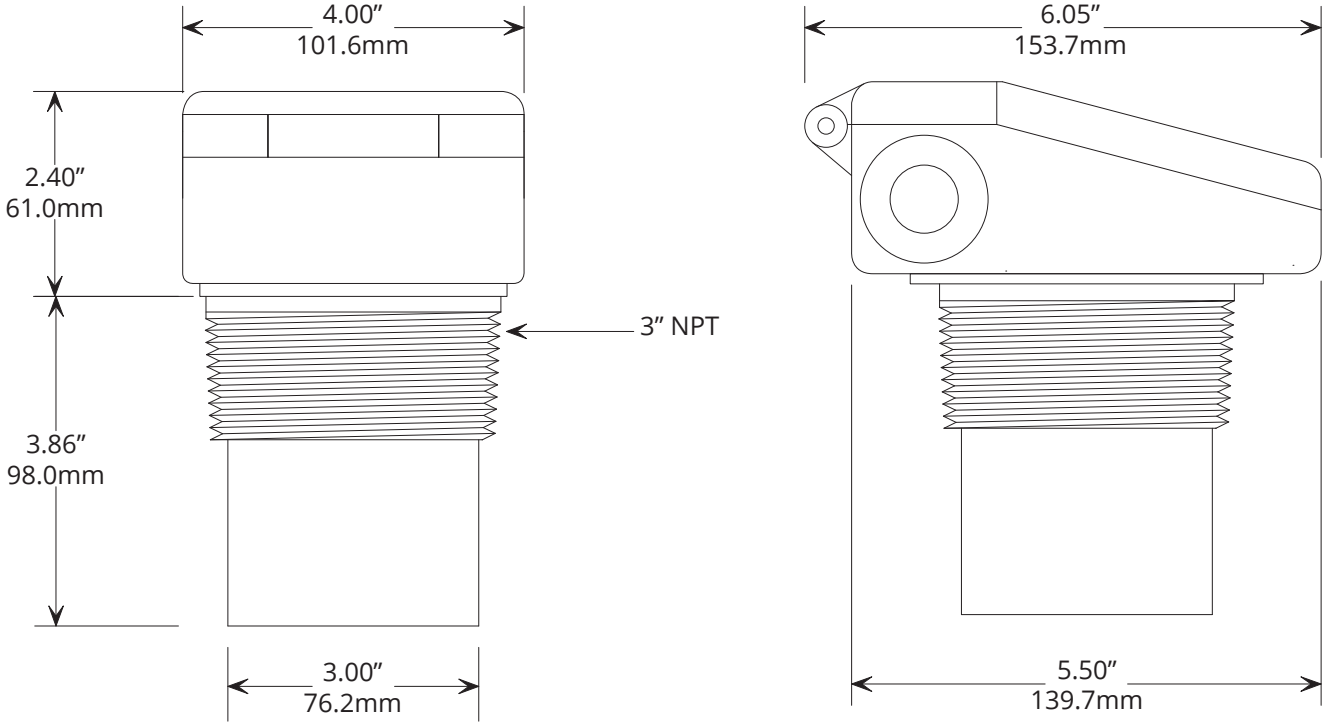
Chapter 1: Specifications and Options

- **Dimensions**

LOE-2126, LOE-6126



LOE-3136



• Specifications

Performance

Operating Range	0.6 - 15.0 ft. / 7 in. - 180 in. / 178mm - 4572mm (6126) 1.0 - 25.0 ft. / 12 in. - 300 in. / 305mm - 7620mm (2126) 1.5 ft. - 40 ft. / 18 in. - 480 in. / 458mm - 12192mm (3136)
Beam Pattern	9° off axis
Transducer Frequency	43 kHz (3136) / 69 kHz (2126, 6126)
Response Time	Programmable, 5 Hz maximum (200 ms)

Communications

Digital Output	Ethernet TCP/IP Modbus Ethernet TCP/IP via embedded webserver (LAN only) Ethernet TCP/IP to APG-provided website 2 Isolated Solid State Relays
Inputs	RS-485 Modbus (up to 10 slave sensors)

Electrical

Operational Supply Voltage (at sensor)	48 VDC via POE (requires injector or switch) 12-28 VDC
Current Draw	40 mA @ 48 VDC 80 mA @ 24 VDC 130 mA Max (Isolated SSRs)
Power Rating	2.0 W Max

Accuracy

Accuracy	±0.25% of detected range
Resolution	0.1 inch (2.54 mm)

Environmental

Operating Temperature	-40 to 60°C (-40 to 140°F)
Internal Temperature Compensation	Yes
Enclosure Protection	IP65

Materials of Construction

Transducer Housing	PVDF
Upper Housing	PC/PET
Transducer Type	Ceramic, PVDF faced

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Mounting

LOE-2126	2” Ø NPT
LOE-3136	3” Ø NPT
LOE-6126	2” Ø NPT

Compatible APG Modbus Senors

Ultrasonic	MNU
Magnetostrictive	MPX-E1, MPX-R1
Pressure	PT-400-L5, PT-400-L31, PT-500-L5, PT-500-L31
Controllers	DCR-1006A, MND

• Model Number Configurator

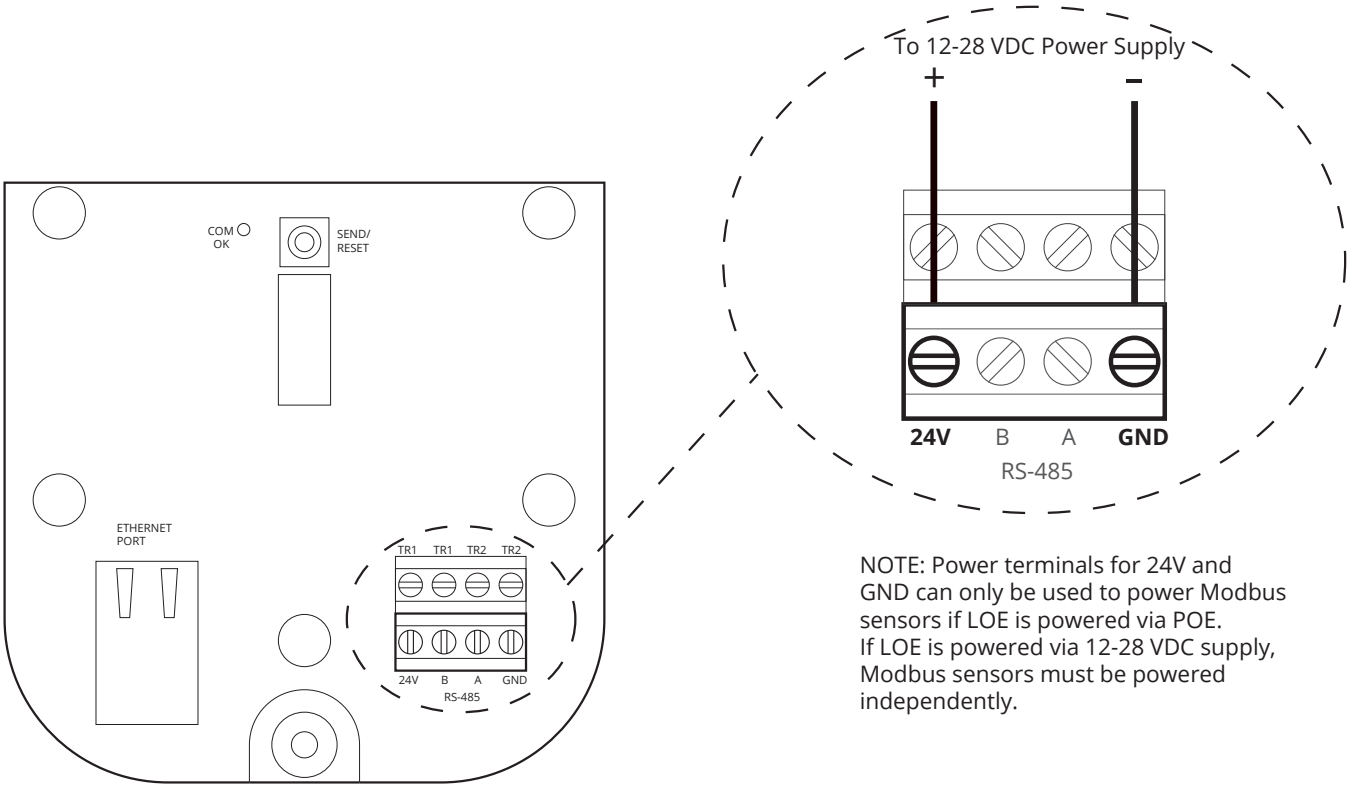
Part Number: LOE - _____
A

A. Model

□ **2126** 1 - 25 ft. (305mm - 7620mm); 69 kHz; 2” NPT threads
□ **3136** 1.5 - 40 ft. (458mm - 12192mm); 43 kHz; 3” NPT threads
□ **6126** 0.6 - 15 ft. (178mm - 4572mm); 69 kHz; 2” NPT threads

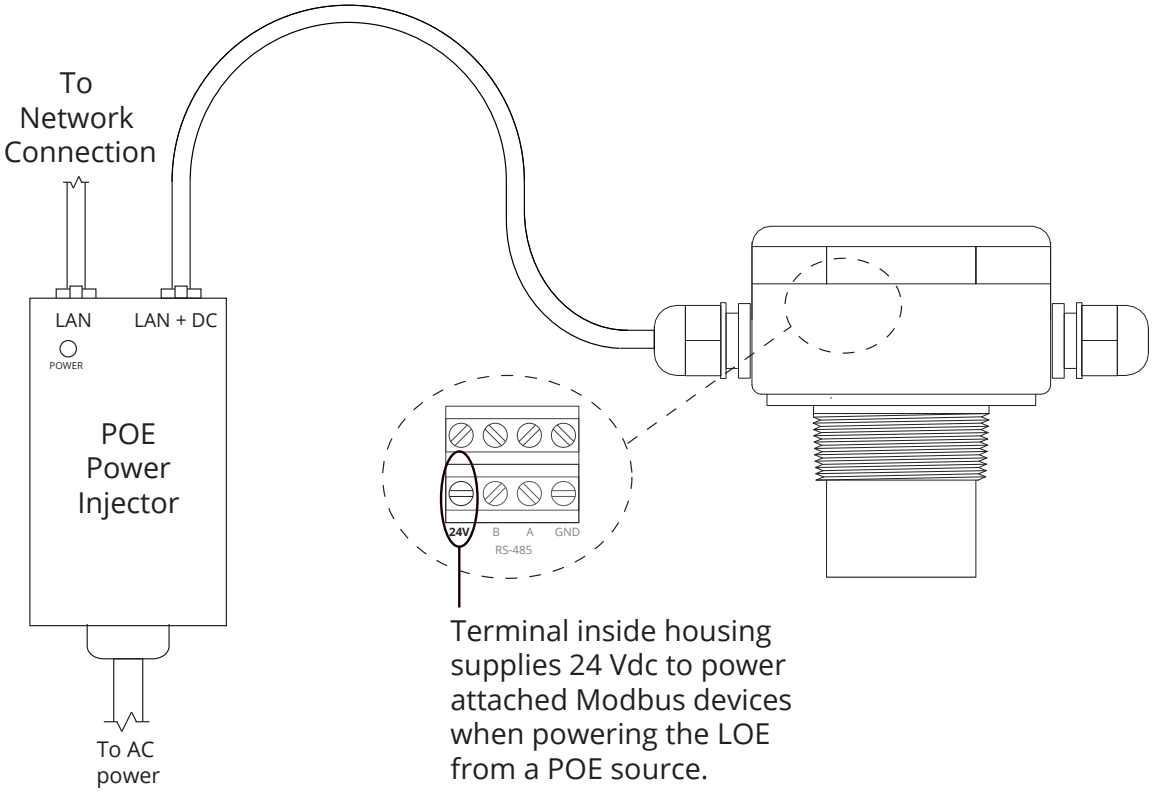
- **System Wiring Diagrams**

External 12-28 VDC Source Wiring



NOTE: Power terminals for 24V and GND can only be used to power Modbus sensors if LOE is powered via POE.
If LOE is powered via 12-28 VDC supply, Modbus sensors must be powered independently.

POE (Power over Ethernet) Wiring



Terminal inside housing supplies 24 Vdc to power attached Modbus devices when powering the LOE from a POE source.

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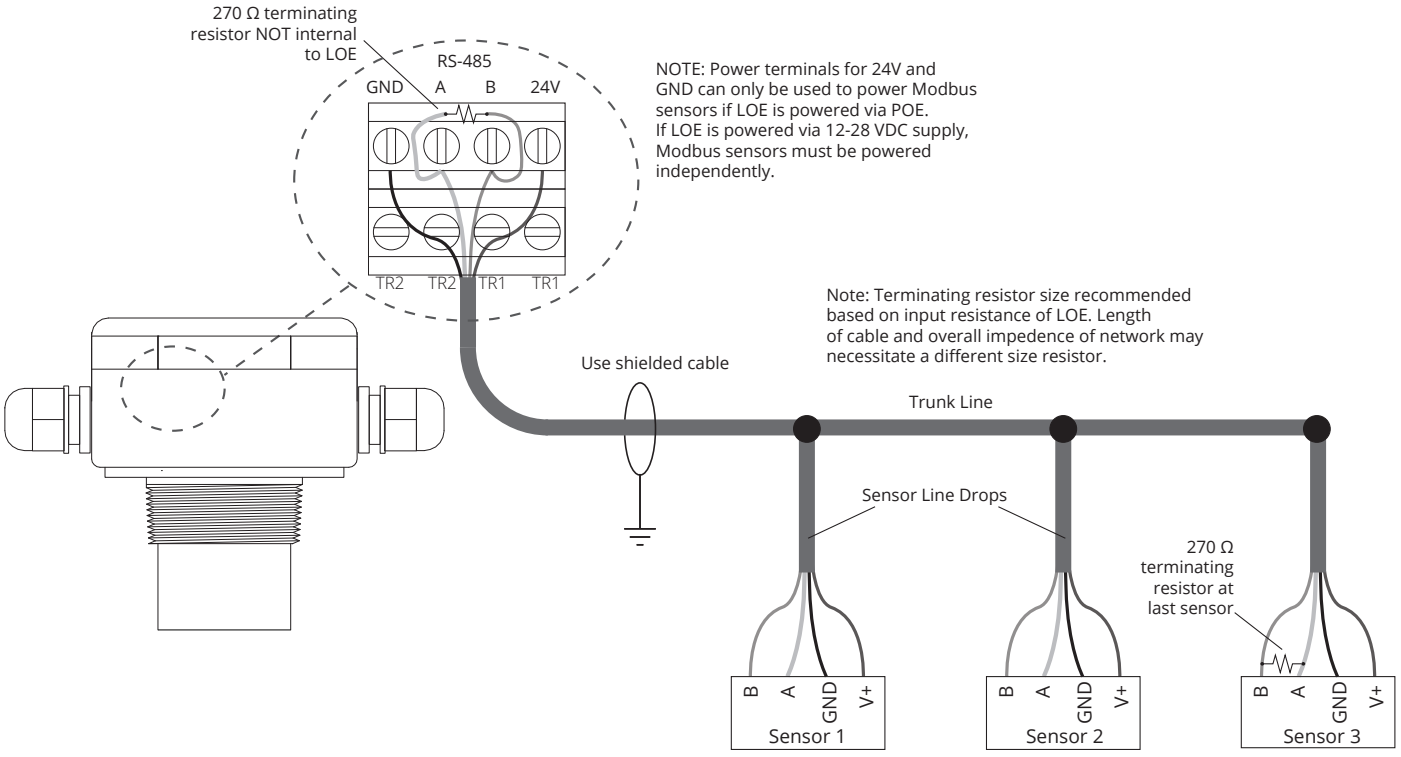
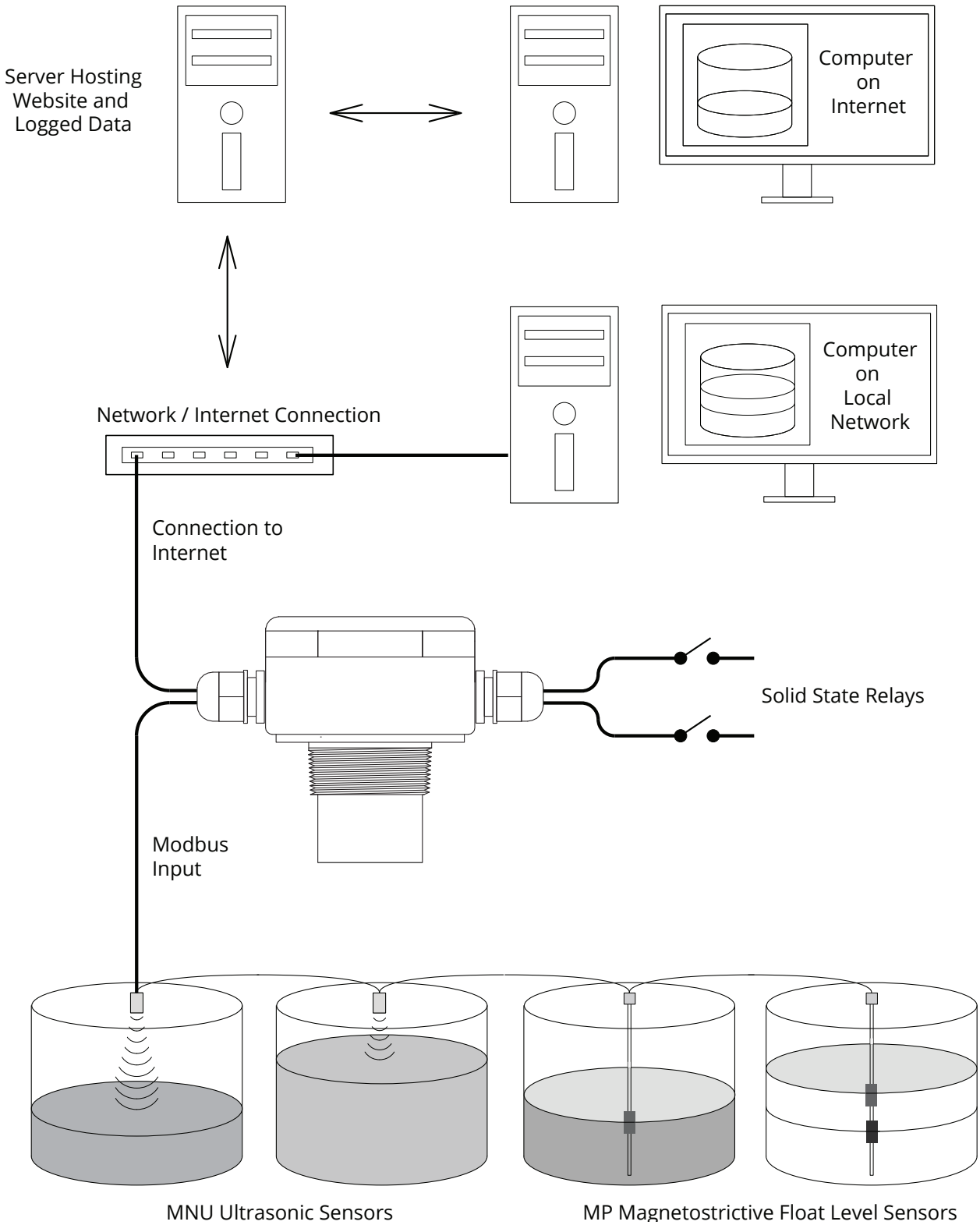
Modbus Sensor Daisy-chain Wiring


270 Ω terminating resistor NOT internal to LOE
RS-485
GND
A
B
24V
TR2
TR2
TR1
TR1
NOTE: Power terminals for 24V and GND can only be used to power Modbus sensors if LOE is powered via POE. If LOE is powered via 12-28 VDC supply, Modbus sensors must be powered independently.
Note: Terminating resistor size recommended based on input resistance of LOE. Length of cable and overall impedence of network may necessitate a different size resistor.
Use shielded cable
Trunk Line
Sensor Line Drops
270 Ω terminating resistor at last sensor
B
A
GND
V+
Sensor 1
Sensor 2
Sensor 3

System Overview - LOE with Modbus network, SSR's and Internet Connection



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Chapter 2: Installation and Removal Procedures and Notes

• Tools Needed

- Flat head screwdriver to remove knockouts for cables.
- If you are using a stand pipe to mount your LOE, you will probably need tools to install the stand pipe.
- For any attached Modbus sensors, please consult each sensor's user manual for installation notes and instructions.

NOTE: For any APG sensor user manual, please visit http://apgsensors.com/support.

• Connection Notes

- Up to 10 Modbus sensors can be connected to the LOE in any combination.
- SSR's are rated for 400V, 130mA max.

IMPORTANT: Each Modbus sensor must be connected to the network individually and assigned a unique Sensor Number before the next sensor can be added.

• Electrical Installation

- Use flat head screwdriver to remove knockouts on either side of LOE housing.
- Insert included cable fittings in knockout holes.
- Connect any output relays first.
- Connect LOE to Ethernet/network.
- Connect independent 12-28 VDC supply if not using POE.
- Connect and set up one Modbus sensor at a time.

IMPORTANT: Multiple Modbus sensors added to the network simultaneously are all assigned the same Modbus address/sensor number: 1. Sensors MUST be added to the network individually.

• Installation Notes

- Mount your LOE sensor so that it has a clear, perpendicular sound path to the surface being monitored. Your sensor should be mounted away from tank or vessel walls and inlets. (See Figure 2.1)
- The sound path should be free from obstructions and as open as possible for the 9° off axis beam pattern.
- If you are using a stand pipe, please see our guide to stand pipes on our website: http://www.apgsensors.com/about-us/blog/how-to-install-a-stand-pipe.

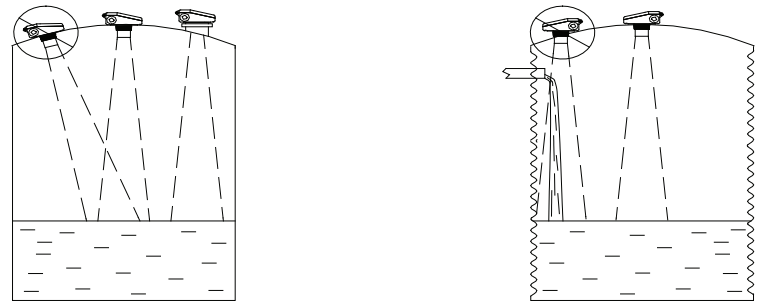

Figure 2.1

• Mounting Instructions

Mounting your LOE is easy if you follow a few simple steps:

- Never over-tighten the sensor.
- Always screw in your sensor by hand to avoid cross-threading. Thread failure can be a problem if you damage threads by over-tightening them or by crossing threads.

IMPORTANT: Do not over tighten! The sensor should be threaded in only hand tight.

NOTE: Do not mount the sensor where the beam will intersect objects such as fill streams, pipes, ladder rungs, wall seams, or corrugated tank walls.

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- **Software Setup**

Initial setup of the LOE and individual Modbus sensors is done via an embedded web server. The embedded server can be accessed by using either the serial number or local IP address of the LOE and a web browser (Internet Explorer, Chrome, Firefox, etc).

> NOTE: Port 6700 must be open on your local network for the LOE to connect.

Accessing LOE Embedded Web Server via Serial Number

The easier way to access the embedded web server is to type loe_xxx into a web browser on a computer connected to the same local network as the LOE. xxx represents the numeric portion of the LOE's serial number. See Figures 2.2 and 2.3.

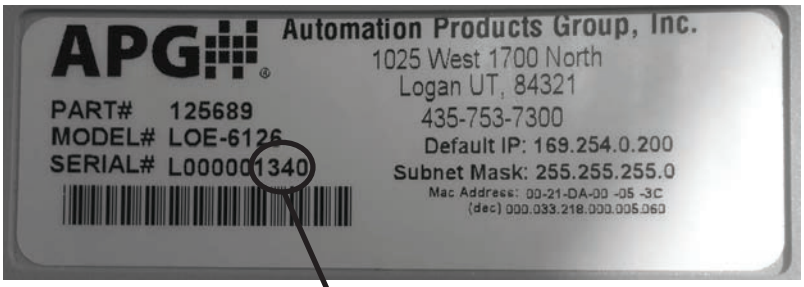


Figure 2.2

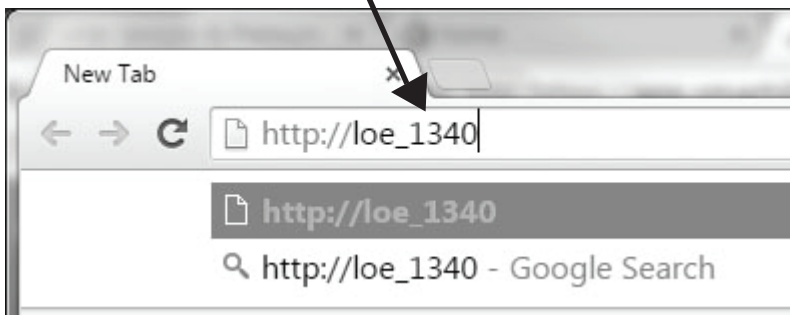


Figure 2.3

> NOTE: If your web browser performs a web search for "loe_xxx" istead of accessing the server, type "http://loe_xxx".

Some networks will block this direct access to the LOE. If this is the case, you will need to use the IP address of your LOE to access the embedded web server. The IP address can be obtained two ways: ask your local network administrator, or logon to your APG-provided website, www.levelandflow.com.

Accessing LOE Embedded Web Server via Local IP Address

Log on to your APG-provided website, and a list of sites will be displayed on your screen (see Figure 2.4). Select the site where the new LOE is installed. From the list of sensors at thie site, select the sensor with the serial number that matches the new LOE. (See Figure 2.5)

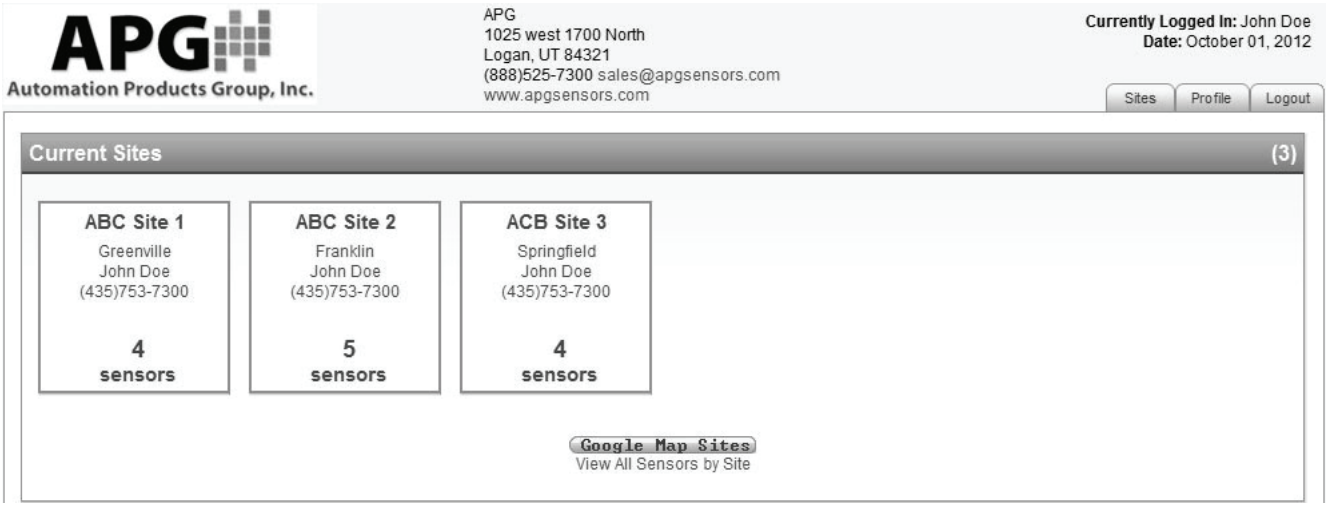


Figure 2.4

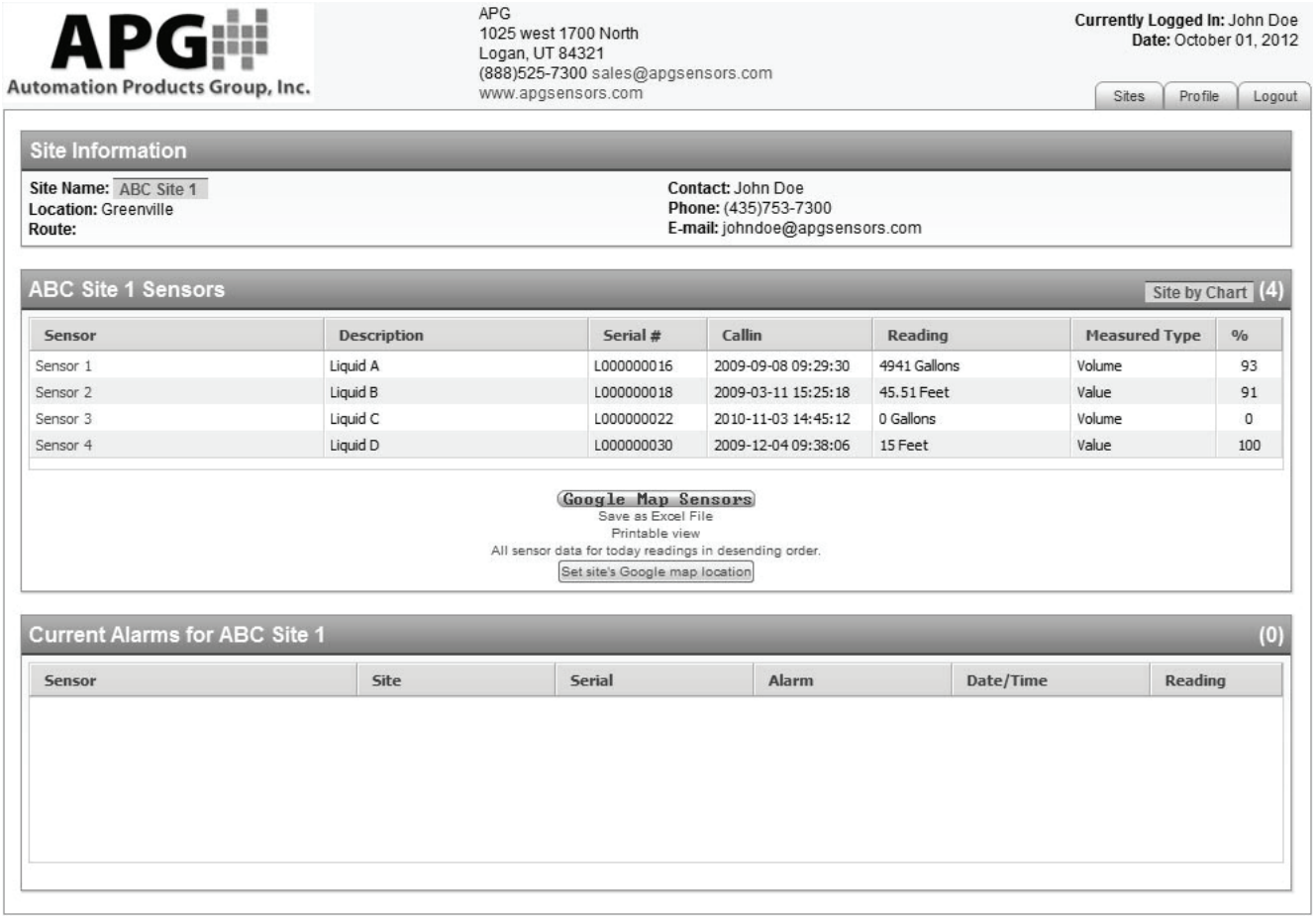

Automation Products Group, Inc.
APG
1025 west 1700 North
Logan, UT 84321
(888)525-7300 sales@apgsensors.com
www.apgsensors.com
Currently Logged In: John Doe
Date: October 01, 2012
Sites
Profile
Logout
Site Information
Site Name: ABC Site 1
Location: Greenville
Route:
Contact: John Doe
Phone: (435)753-7300
E-mail: johndoe@apgsensors.com
ABC Site 1 Sensors
Site by Chart
(4)
Sensor | Description | Serial # | Callin | Reading | Measured Type | %
Sensor 1 | Liquid A | L000000016 | 2009-09-08 09:29:30 | 4941 Gallons | Volume | 93
Sensor 2 | Liquid B | L000000018 | 2009-03-11 15:25:18 | 45.51 Feet | Value | 91
Sensor 3 | Liquid C | L000000022 | 2010-11-03 14:45:12 | 0 Gallons | Volume | 0
Sensor 4 | Liquid D | L000000030 | 2009-12-04 09:38:06 | 15 Feet | Value | 100
Google Map Sensors
Save as Excel File
Printable view
All sensor data for today readings in desending order.
Set site's Google map location
Current Alarms for ABC Site 1
(0)
Sensor | Site | Serial | Alarm | Date/Time | Reading

Figure 2.5

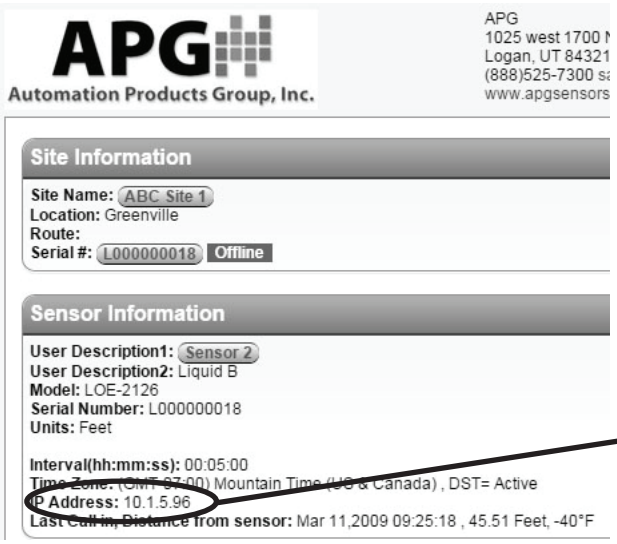


Figure 2.6

On the Sensor Information screen you will see the IP Address of the newly installed LOE. (See Figure 2.6.)

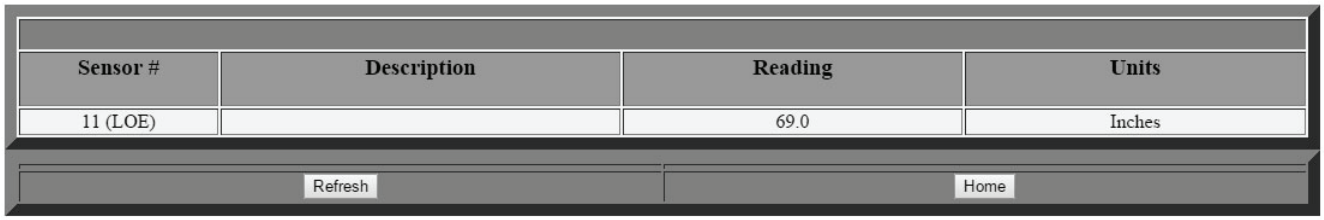
Type the LOE's IP address into your browser's address bar (See Figure 2.7).

Figure 2.7

NOTE: For further information on using your APG-provided remote website, please visit www.apgsensors.com/support for a user manual, or contact us at 1-888-525-7300.

Logging on to the LOE Embedded Web Server

The LOE's embedded webpage should now be open, showing the Main Display page (See Figure 2.8). This page lists the LOE, any Modbus sensors attached to the LOE, and displays each sensor's current reading. The LOE is displayed as sensor #11. The configured sensor number for each Modbus sensor will show as its Sensor Number. Every new Modbus sensor defaults to sensor number 1.



Sensor #	Description	Reading	Units
11 (LOE)		69.0	Inches

Refresh Home

Figure 2.8

IMPORTANT: Multiple Modbus sensors added to the network simultaneously are all assigned the same sensor number: 1. Sensors must be added to the network individually.

Click on Home to bring up the Menu page (See Figure 2.9). The first menu link clicked during each session will prompt a User Name and Password login for the LOE (See Figure 2.10). The default User Name is **admin**, and the default Password is **password**.

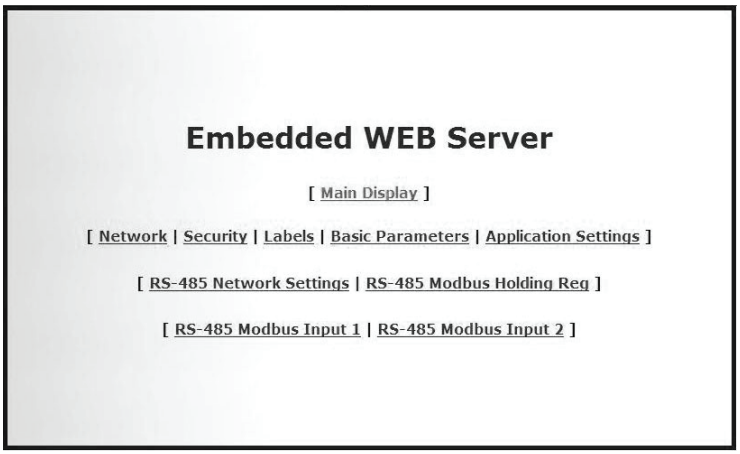

Embedded WEB Server
[Main Display]
[Network | Security | Labels | Basic Parameters | Application Settings]
[RS-485 Network Settings | RS-485 Modbus Holding Reg]
[RS-485 Modbus Input 1 | RS-485 Modbus Input 2]

Figure 2.9

Figure 2.10

NOTE: See the Security Setting Menu (Page 37) to change this user name and password.

Assigning Modbus Senor Numbers

Click on RS-485 Network Settings to bring up the RS485 Settings page (See Figure 2.11). See section RS-485 Network Settings for a full descrition of each parameter in this menu (Page 38).

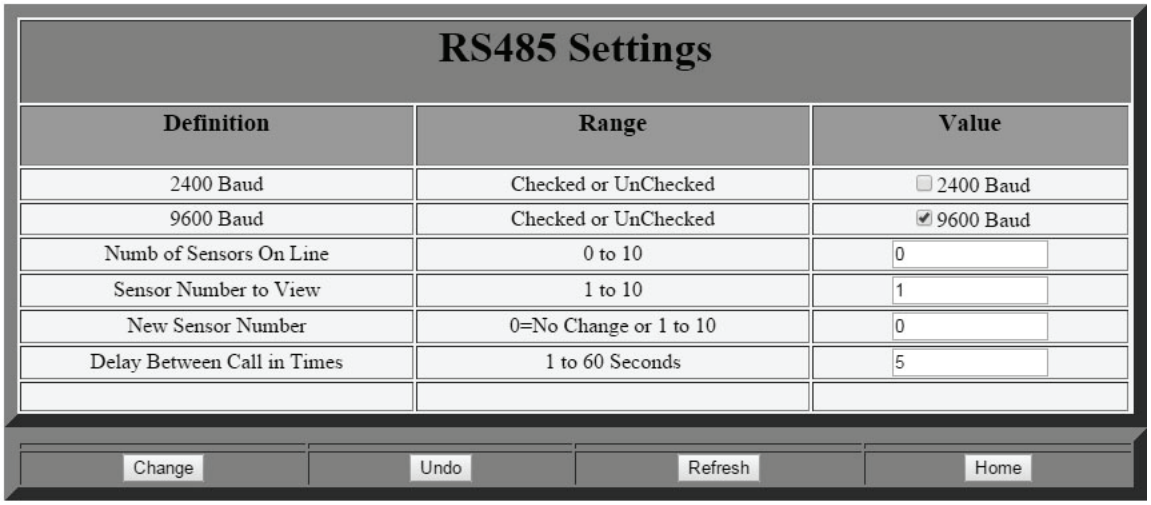


Figure 2.11

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Change *Numb of Sensors On Line* to reflect the total number of Modbus sensors you will be connecting to your LOE. Click Change to send the new value to the LOE.

With *Sensor Number to View* set to 1 (for the latest sensor added to the Modbus network), set *New Sensor Number* to the highest available number. Click Change to send the new value to the LOE.

Repeat this process for each Modbus sensor as it is added to the network.

NOTE: If you control the power to each Modbus sensor seperately, powering up a new sensor after assigning a Modbus address to the previous sensor will allow you to assign an address to the new sensor without leaving the RS845 Settings Menu.

IMPORTANT: None of parameters in the RS485 Settings menu automatically update. Each one must be manually configured.

- **Removal Instructions**

  - Disconnect power to the LOE first.
  - Disconnect network connection.
  - Disconnect any sensors, relays, and switched inputs.
  - Remove the LOE and store it in a dry place, at a temperature between -40° F and 180° F.

Chapter 3: Programming with Modbus TCP/IP

• Modbus Polling via Ethernet with Modbus TCP/IP

Using the LOE's IP address, and port number 502, readings can be polled from the LOE for any attached sensors via RS-485 Modbus commands. Up to 14 16-bit Input Registers, beginning with register 299, can be polled with a single command. Below is a sample Modbus command illustrating the necessary syntax.

Example:

00 01 : Transaction Identifier
00 00 : Protocol Identifier
00 06 : Message Length (6 bytes to follow)
0B : The Reporting Unit Identifier [sensor number] (0B hex = 11)
04 : The Function Code (04 = read Input Registers)
01 2E : The Data Address of the first register requested. (12E hex + 1 = 303)
00 02 : The total number of registers requested. (read 2 registers, i.e. 303 to 304)

Byte order (hex values)
00 01 00 00 00 06 0B 04 01 2E 00 02

Notes:

- Reporting Unit indicates the sensor reading being polled from the LOE, in hex. 01 - 0A are for Modbus sensors 1 - 10 attached to the LOE. 0B (i.e. sensor 11) reads the values from the LOE sensor (See Figure 2.8). Unused registers (i.e., those not associated to an attached sensor) will return zeros when polled.

- Function Code 04 reads the Input Registers. No other functionality (e.g., polling from or writing to Holding Registers) is supported via Modbus TCP/IP with the LOE. Complete control functionality is available through the embedded web server and through your APG-provided website (www.levelandflow.com).

- Data Address of registers, decimal to "hex minus 1" conversion:

Decimal Address	Hex minus 1	Decimal Address	Hex minus 1
299	12A	306	131
300	12B	307	132
301	12C	308	133
302	12D	309	134
303	12E	310	135
304	12F	311	136
305	130	312	137

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- Total number of registers requested, up to 14, given in hex:

# of Registers	Hex equivalent	# of Registers	Hex equivalent
01	01	08	08
02	02	09	09
03	03	10	0A
04	04	11	0B
05	05	12	0C
06	06	13	0D
07	07	14	0E

• LOE Generic Modbus Register List

Input Registers (0x04)

Register	Returned Data
30299	Sensor Type
30300	Distance/Level 1, Top (in mm, unsigned)
30301	Distance/Level 2, Bottom (in mm, unsigned)
30302	Sensor Temperature Reading (in ^{0}C, signed)
30303-30304	Calculated 1 (raw)
30305-30306	Calculated 2 (raw)
30307 (upper bits)	Version
30307 (lower bits)	Signal Strength
30308	Battery Voltage
30309 (upper bits)	Sensor Trip 1 Alarm
30309 (lower bits)	Sensor Trip 1 Status
30310 (upper bits)	Sensor Trip 2 Alarm
30310 (lower bits)	Sensor Trip 2 Status
30311 (upper bits)	Sensor Trip 3 Alarm
30311 (lower bits)	Sensor Trip 3 Status
30312 (upper bits)	Sensor Trip 4 Alarm
30312 (lower bits)	Sensor Trip 4 Status

This is the list of generic Input Registers for polling the LOE and any connected sensors. Actual registers used vary by sensor. Please see the user manual for each sensor for a full and accurate list of registers.

NOTE: For more information about Modbus RTU, please visit www.modbus.org.

- **Modbus Programming of Individual Sensors**

The LOE does NOT support full Modbus programming of attached sensors. Full control and configuration of individual sensors is supported through the LOE's embedded web server and through your APG-provided webpage, www.levelandflow.com.

> NOTE: For any APG sensor user manual, please visit http://apgsensors.com/support.

Chapter 4: LOE Embedded Web Server

- **Accessing the LOE Embedded Web Server**

See the Software Setup section of chapter 2 (pages 9 - 11) for instructions for accessing and signing into the LOE embedded web server.

- **Navigating the LOE Embedded Web Server**

The LOE embedded web server has two primary screens--the Main Display Page (Figure 4.1) and Menu Page (Figure 4.2)--and a screen for each of 9 submenus. The submenus can be understood in three groups:

- LOE Sensor Input Configuration Submenus
  - Basic Parameters
  - Application Settings
- Modbus Sensor Configuration Registers
  - RS-485 Modbus Input Reg
  - RS-485 Modbus Holding 1
  - RS-485 Modbus Holding 2
- LOE Utility Menus
  - Network
  - Security
  - Label
  - RS-485 Network Settings

The Menu Page also has a link back to the Main Display Page.

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Sensor #	Description	Reading	Units
11 (LOE)		73	Gallons

Refresh | Home

Figure 4.1

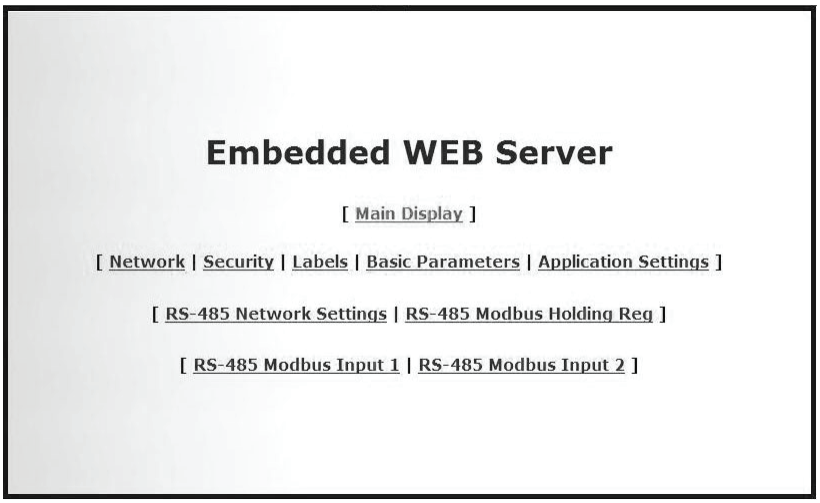
Embedded WEB Server
[Main Display]
[Network | Security | Labels | Basic Parameters | Application Settings]
[RS-485 Network Settings | RS-485 Modbus Holding Reg]
[RS-485 Modbus Input 1 | RS-485 Modbus Input 2]

Figure 4.2

- **LOE Sensor Configuration Submenus**

LOE Application Settings

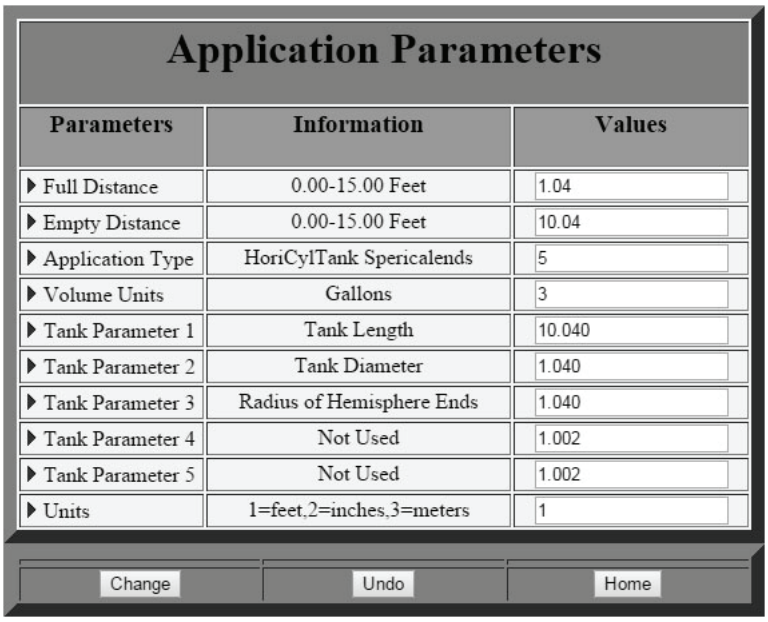

Figure 4.3

The Application Parameters menu configures the application-specific parameters applied to the calculated reading from the LOE sensor.

PARAMETER	**RANGE**
Full Distance	0 - Sensor Maximum

Full Distance sets the distance from the LOE sensor Zero Point (See Figures 4.5 - 4.7) to the full level of the vessel being monitored. Not used when Application Type is set to 0 (Value).

PARAMETER	**RANGE**
Empty Distance	0 - Sensor Maximum

Empty Distance sets the distance from the LOE sensor Zero Point (See Figure 4.5 - 4.7) to the empty level of the vessel being monitored. Not used when Application Type is set to 0 (Value).

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PARAMETER	RANGE
Application Type	0 = Value (Distance) 1 = Level 2 = Volume of Standing Cylindrical Tank with or without Hemispherical Bottom 3 = Volume of Standing Cylindrical Tank with or without Conical Bottom 4 = Volume of Standing Rectangular Tank with or without Chute Bottom 5 = Volume of Horizontal Cylindrical Tank with or without Spherical Ends 6 = Volume of Spherical Tank 7 = Pounds (Linear Scaling) 8 = User Defined Units 9 = Volume of Vertical Oval Tank 10 = Volume of Horizontal Oval Tank

Application Type is used to choose the parameter configuration to convert the distance of *Distance* into the configured reading on the Main Display Page (See Figure 4.1). After selecting an *Application Type* and pressing "Change," the Application Parameters menu updates to reflect the parameters of the chosen application.

See *Tank Parameters* for an explaination of each *Application Type* and its associated parameters.

PARAMETER	RANGE
Volume Units	1 = Feet^3 2 = Million Feet^3 3 = Gallons 4 = Meters^3 5 = Liters 6 = Inches^3 7 = Barrels

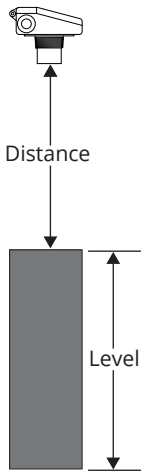
Volume Units selects the units of measure for the configured reading on the Main Display Page (See Figure 4.1) when a volumetric application is selected. The settings is not used when the Application Type is set to 0, 1, 7, or 8.

PARAMETER	RANGE
Units	1 - feet 2 - inches 3 - meters

Units is used to select the units of measurement for distance or level applications. The units will also determine the resolution of Basic and Application Parameters. The resolution is: feet 0.01, inches 0.1, and meters 0.001.

Tank Parameters

Application Type	Tank Parameter	Function
0 - Distance	Parameter 1	Not Used
	Parameter 2	Not Used
	Parameter 3	Not Used
	Parameter 4	Not Used
	Parameter 5	Not Used

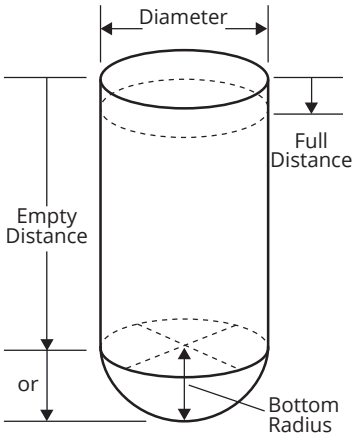


Distance (factory default) measures the distance from the Zero Point of the LOE sensor to the target surface.

Application Type	Tank Parameter	Function
1 - Level	Parameter 1	Not Used
	Parameter 2	Not Used
	Parameter 3	Not Used
	Parameter 4	Not Used
	Parameter 5	Not Used

Level calculates the depth or level of the vessel being monitored, based on the *Full Distance* and *Empty Distance*.

Application Type	Tank Parameter	Function
2 - Standing Cylindrical Tank with Hemispherical Bottom	Parameter 1	Tank Diameter
	Parameter 2	Bottom Radius
	Parameter 3	Not Used
	Parameter 4	Not Used
	Parameter 5	Not Used



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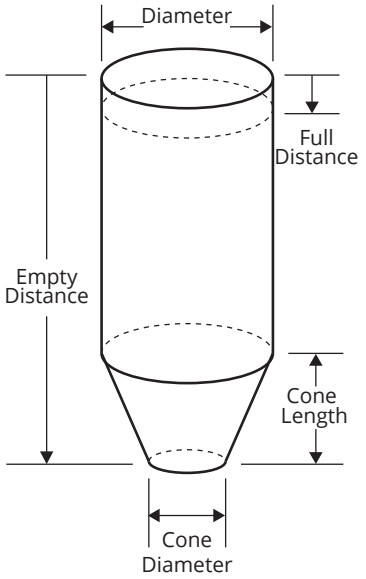
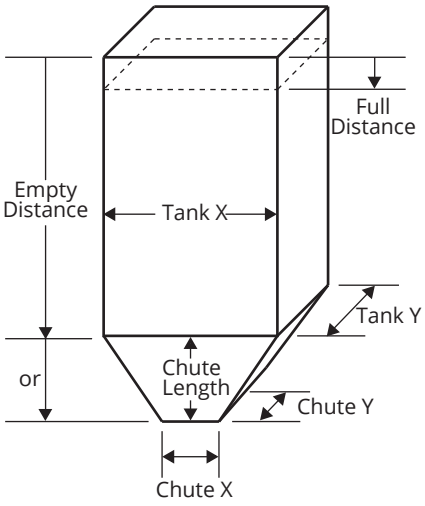
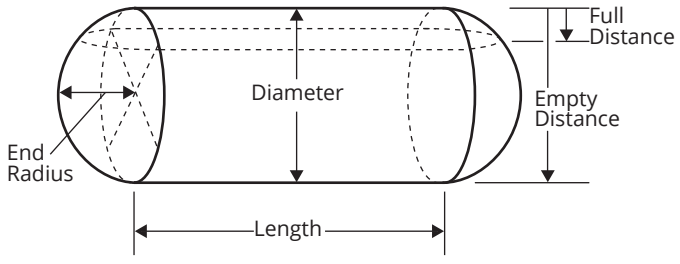
Application Type	Tank Parameter	Function
3 - Standing Cylindrical Tank with Conical Bottom	Parameter 1	Tank Diameter
	Parameter 2	Bottom Radius
	Parameter 3	Cone Length (Height)
	Parameter 4	Not Used
	Parameter 5	Not Used



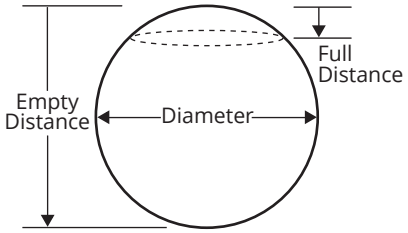
Application Type	Tank Parameter	Function
4 - Standing Rectangular Tank with Chute	Parameter 1	Tank X Dimension
	Parameter 2	Tank Y Dimension
	Parameter 3	Chute X Dimension
	Parameter 4	Chute Y Dimension
	Parameter 5	Chute Length (Height)



Application Type	Tank Parameter	Function
5 - Horizontal Cylindrical Tank with Spherical Ends	Parameter 1	Tank Length
	Parameter 2	Tank Diameter
	Parameter 3	Radius of Ends
	Parameter 4	Not Used
	Parameter 5	Not Used



Application Type	Tank Parameter	Function
6 - Spherical Tank	Parameter 1	Tank Diameter
	Parameter 2	Not Used
	Parameter 3	Not Used
	Parameter 4	Not Used
	Parameter 5	Not Used



Application Type	Tank Parameter	Function
7 - Pounds	Parameter 1	Multiplier
(Linear Scaling)	Parameter 2	Unit Definition (label)
	Parameter 3	Not Used
	Parameter 4	Not Used
	Parameter 5	Not Used

Pounds allows for a multiplier (*Parameter 1*) to be applied to the calculated level measurement, creating a linear scalar as the output to configured reading on the Main Display Page. Such a multplier could convert the distance or level measurement of a tank with simple geometry into a measurement of weight.

Application Type	Tank Parameter	Function
8 - User Defined Units	Parameter 1	Not Used
	Parameter 2	Not Used
	Parameter 3	Not Used
	Parameter 4	Not Used
	Parameter 5	Not Used

User Defined Units is not used by the LOE. *Application Type* 8 can be selected, but after leaving the Application Parameters Menu, *Application Type* reverts to 0.

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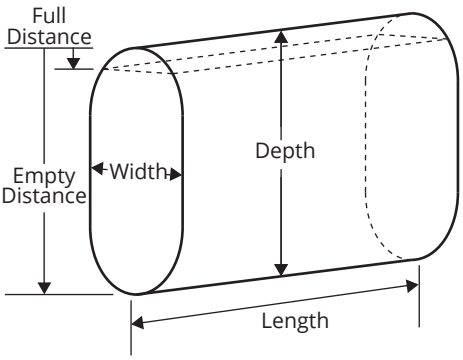
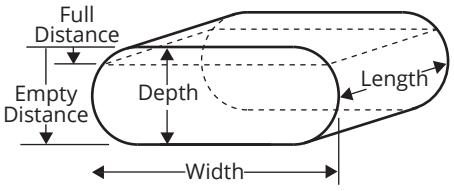
Application Type	Tank Parameter	Function
9 - Vertical Oval Tank	Parameter 1	Tank Length
	Parameter 2	Tank Depth
	Parameter 3	Tank Width
	Parameter 4	Not Used
	Parameter 5	Not Used



Application Type	Tank Parameter	Function
10 - Horizontal Oval Tank	Parameter 1	Tank Length
	Parameter 2	Tank Depth
	Parameter 3	Tank Width
	Parameter 4	Not Used
	Parameter 5	Not Used



Basic Parameters

Basic Parameters

Parameters	Information	Values		Parameters	Information	Values
				▸ Offset	-10.00 to +10.00 Feet	0.04
▸ Sensitivity	0 to 100	100		▸ Max Distance	2.00-15.00 Feet	14.00
▸ Blanking	0-15.00 Feet	0.84	Change	▸ Trip1 Dist	0.00-15.00 Feet	2.54
▸ Pulses	0 to 20	20		▸ Trip1 Window	0.00-15.00 Feet	1.04
▸ Gain Control	0=Man,1=Auto,2=Hard,3=Soft,4=Auto Soft	1		▸ Trip1 Type Output	(0 to 29) 3=Far	3
▸ Average	1 to 32	4	Undo	▸ Trip2 Dist	0.00-15.00 Feet	3.04
▸ Window	0.00-15.00 Feet	0.84		▸ Trip2 Window	0.00-15.00 Feet	1.04
▸ Out of Range Samples	0 to 250	4		▸ Trip2 Type Output	(0 to 30) 3=Far	3
▸ Sample Rate	1 to 5 Hertz	4		▸ Retry Time	30 to 180 Seconds	30
▸ Multiplier	0 to 1.999	1.003				
▸ Temp Comp	0=Off,1=On	0		▸ Remote Call in Time	1 to 86400 Seconds	60
			0	▸ Remote Bytes	8 or 160	8
▸ Distance	0.00-15.00 Feet	4.81 Feet	Refresh			
▸ Signal Strength	0-100 (100=Best),Pulses,Sensitivity	94, 1, 47		▸ Trip1 Status	Green=ON Red=OFF	Trip1 ON
▸ Temperature	Readout in Celsius	24 C	Home	▸ Trip2 Status	Green=ON Red=OFF	Trip2 ON

Figure 4.4

PARAMETER	RANGE
Sensitivity	0 - 100%

Sensitivity sets the level of gain that is applied to the echo. When operating in AutoSense, Hard-Target, or Soft-Target (see *Gain Control*), *Sensitivity* sets an upper limit for the amplification that can be applied to the echo. If operating in Manual, this parameter sets the gain.

When using manual gain control, set *Sensitivity* to the minimum value that will allow the target to be reliably tracked through the full range of expected environmental conditions.

IMPORTANT: Parameter values stored on the LOE will not update until the "Change" button is clicked.

PARAMETER	RANGE
Blanking	Determined by sensor model

Blanking sets the blanking distance, which is the zone from the Zero Point of the sensor to the point from which the first echo will be accepted. While blanking distance can be used to ignore unwanted targets--such as welds, seams, pipe fittings, or gaskets--between the sensor and the closest acceptable target level, such objects generally create additional reflections and echoes, which are hard to filter out. More often, blanking distance is used for a sensor installed in a stand pipe.

Because of the physical properties of an ultrasonic sensor, objects cannot be detected closer than approximately 1 foot from the face of most transducers (7 inches for LOE-6126). However, this distance varies according to how much energy is being transmitted (*Pulses*) and the installation.

IMPORTANT: *Blanking* is always measured from the Zero Point of the sensor. See Figures 4.5 - 4.7.

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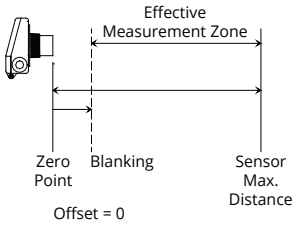

Figure 4.5

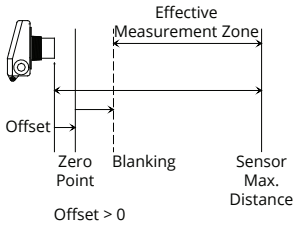

Figure 4.6

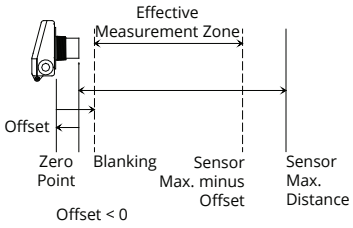

Figure 4.7

PARAMETER	RANGE
Pulses	0-20

Pulses sets the maximum number of pulses the sensor can transmit when operating in AutoSense, Hard-Target, or Soft-Target (see *Gain Control*), or sets the number of pulses when operating in Manual. The more pulses that are sent in a burst, the stronger the returning echo.

When operating in Manual, increase the strength of the transmission by increasing *Pulses* for detecting soft targets in damping environments. In acoustically active environments or small enclosed areas, decrease *Pulses* to reduce multiple echoes.

PARAMETER	RANGE
Gain Control	0 = Manual 1 = AutoSense 2 = Hard-Target 3 = Soft-Target

Gain Control selects the control mode for the LOE sensor's gain settings (*Sensitivity* and *Pulses*). In AutoSense, the sensor automatically adjusts the sensitivity and pulses for the best quality return signal. Manual, Hard Target, and Soft Target are user controlled scenarios. In Manual, the user is in full control of *Sensitivity* and *Pulses*. For Hard and Soft Target, the user sets maximum *Sensitivity* and *Pulses*, but the overall gain is either ramped up slowly (Hard Target) or quickly (Soft Target) by the sensor.

PARAMETER	RANGE
Average	1-32

Average sets the number of qualified samples to average for the displayed reading. Qualified samples are placed in a first-in, first-out buffer, the contents of which are averaged for *Distance*. The larger the number of qualified samples being averaged, the smoother the output reading will be, and the slower the reading will be to react to quick changes.

PARAMETER	RANGE
Window	0 - Sensor Maximum

Window determines the corresponding physical range for qualified samples, based on the current *Distance*. Samples beyond the +/- *Window* range of the current *Distance* will not qualify unless the average moves. Samples outside the extents of the *Window* are written to the *Out of Range Samples* buffer. (See Figure 4.8.)

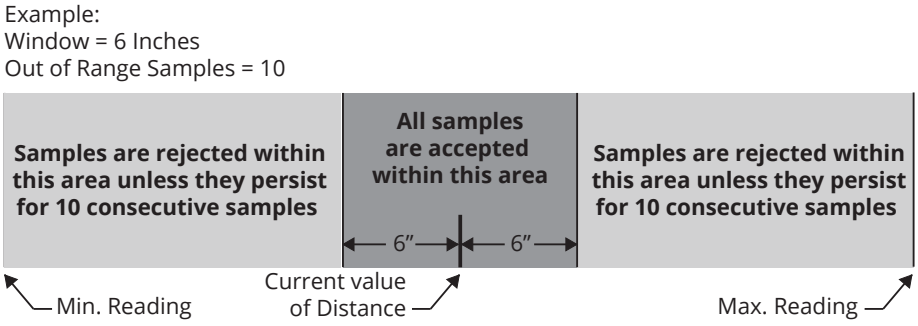
Example:
Window = 6 Inches
Out of Range Samples = 10
Samples are rejected within this area unless they persist for 10 consecutive samples
All samples are accepted within this area
6″
6″
Samples are rejected within this area unless they persist for 10 consecutive samples
Min. Reading
Current value of Distance
Max. Reading

Figure 4.8

PARAMETER	RANGE
Out of Range Samples	0-250

Out of Range Samples sets the number of consecutive samples outside the *Window* necessary to automatically adjust the current *Distance* and move the *Window*.

PARAMETER	RANGE
Sample Rate	1 - 5 Hz

Sample Rate is the number of sample readings taken by the LOE every second.

PARAMETER	RANGE
Multiplier	0 - 1.999

Multiplier is used to calibrate the LOE sensor for variations in the speed of sound due to variations in atmospheres. The default of 1.000 is used for most applications.

PARAMETER	RANGE
Temp Comp.	0 = Off
	1 = On

Temperature Compensation activates or deactivates the LOE's internal temperature compensation circuit. The speed of sound changes with changes in temperature, therefore changes in temperature can affect distance measurements. These effects can be minimized by activating temperature compensation.

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PARAMETER	RANGE
Offset	-10 ft - + 10ft

Offset is used to change the Zero Point of the LOE sensor. The Zero Point of the sensor is the point from which the calculated distance is measured. When the Offset is set to 0, the Zero Point of the sensor is at the face of the transducer (See Figure 4.5). A positive setting will move the Zero Point forward, in front of the sensor face (See Figure 4.6). Setting the Offset to a negative number will move the Zero Point backward, behind the sensor face (See Figure 4.7).

In all cases, Blanking is measured from the end of Offset, and the effective measurement zone of the sensor begins at the forward end of Blanking. If Offset is more negative than Blanking is positive, the net difference will be a loss in sensor maximum range (See Figure 4.7).

PARAMETER	RANGE
Max Distance	Determined by sensor model

Maximum Distance sets the maximum acceptable signal range (up to the physical maximum of the sensor), measured from the Zero Point. Signals beyond the *Maximum Distance* are ignored. Under Loss of Echo conditions, the *Distance* reading will display the *Maximum Distance*.

LOE Readings

▸ Distance	0.00-15.00 Feet	4.81 Feet
▸ Signal Strength	0-100 (100=Best),Pulses,Sensitivity	94, 1, 47
▸ Temperature	Readout in Celsius	24 C

Figure 4.9

Reading Type	Range
Distance	Determined by model

Distance displays the distance from the sensor to the detected target in the units selected in the *Units* parameter in the Application Parameters Menu (See Figure 4.3). This reading is always Distance, regardless of the *Application Type* selected in the Application Parameters Menu.

Reading Type	Range
Signal Strength	0 - 100

Signal Strength displays the strength of the signal being received by the sensor. 0 represents the lowest quality signal, and 100 represents the highest quality.

Reading Type	Range
Temperature	

Temperature displays the current temperature of the thermal device in the LOE sensor body.

LOE Trip Outputs and Settings

▸ Trip1 Dist	0.00-15.00 Feet	2.54
▸ Trip1 Window	0.00-15.00 Feet	1.04
▸ Trip1 Type Output	(0 to 29) 3=Far	3
▸ Trip2 Dist	0.00-15.00 Feet	3.04
▸ Trip2 Window	0.00-15.00 Feet	1.04
▸ Trip2 Type Output	(0 to 30) 3=Far	3

Figure 4.10

▸ Trip1 Status	Green=ON Red=OFF	Trip1 ON
▸ Trip2 Status	Green=ON Red=OFF	Trip2 ON

Figure 4.11

The LOE has 2 output relays that can be configured to turn on or off based on the *Distance* reading of the sensor.

Trip Type Outputs are configured with two independent digits: the first for Alarm Type (Blank, 1, or 2), and the second for Trip Condition (0-5, 7, or 9).

PARAMETER	**RANGE**
Trip Distance	0 - Sensor Max Distance

Trip Distance sets the value of the primary trip position, which is closest to the Zero Point of the sensor.

PARAMETER	**RANGE**
Trip Window	0 - Sensor Max Distance

Trip Window sets the value from the primary trip position to the secondary trip position, which is farther from the sensor's Zero Point.

Alarm Type
Blank_ - No Alarm

Designates that no alarm is to be activated or deactivated on the remote APG-provided website (i.e., www.levelandflow.com) for the indicated Trip Condition. To initiate only the visual Trip Status indicator (See Figure 4.11) for Trip Condition 3, *Trip Type* would be set to **3**.

Alarm Type
1_ - Active Alarm

Designates the active trip point as a web alarm condition. To initiate web alarm whenever the Trip Condition 3 is ON, *Trip Type* would be set to **13**.

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Alarm Type

2_ - Inactive Alarm

Designates an inactive trip point as a web alarm condition. To initiate a web alarm whenever the Trip Condition 3 is OFF, *Trip Type* would be set to **23**.

Trip Condition

0 - Near

Near activates the Trip whenever the *Distance* is less than the *Trip Distance* setting.

Trip Condition

1 - Exclusive

Exclusive activates the Trip whenever the *Distance* is less than the *Trip Distance* setting OR greater than the *Trip Distance* + *Trip Window* settings.

Trip Condition

2 - Hysteresis Near

Hysteresis Near activates the Trip whenever the *Distance* becomes less than than the *Trip Distance* setting. The Trip remains activated until the *Distance* becomes greater than the *Trip Distance* + *Trip Window* settings. The Trip then remains off until the *Distance* becomes less than the *Trip Distance* setting again.

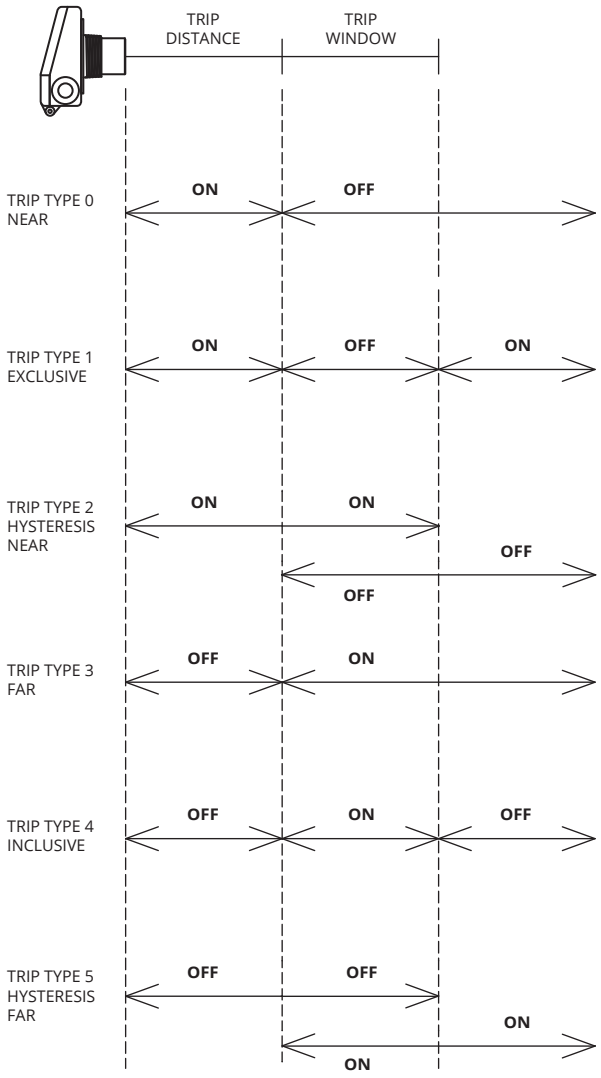

Figure 4.12

Trip Condition

3 - Far

Far activates the Trip whenever the *Distance* is greater than the *Trip Distance* setting.

Trip Condition

4 - Inclusive

Exclusive activates the Trip whenever the *Distance* is greater than the *Trip Distance* setting AND less than the *Trip Distance* + *Trip Window* settings.

Trip Condition

5 - Hysteresis Far

Hysteresis Far activates the Trip whenever the *Distance* becomes greater than the *Trip Distance* + *Trip Window* settings. The Trip remains activated until the *Calc. Dist,Level,Volume* becomes less than the *Trip Value* setting. The Trip remains off until the *Distance* becomes greater than the *Trip Distance* + *Trip Window* settings again.

Trip Condition

6 - Disable Trip Relay
16 - Turn on Trip Relay
26 - N/A

Disable de-activates the Trip or SS Relay output.

Trip Condition

7 - Loss of Echo

Loss of Echo activates the output when the maximum calculated reading is reached.

Trip Condition

8 - Timed Interval

Timed Interval activates the output for a set amount of seconds every set amount of minutes (See Figure 4.13). When Trip Type is set to 8, *Trip Distance* and *Trip Window* are changed to “Interval Time (minutes)” and “On Time (seconds)”.

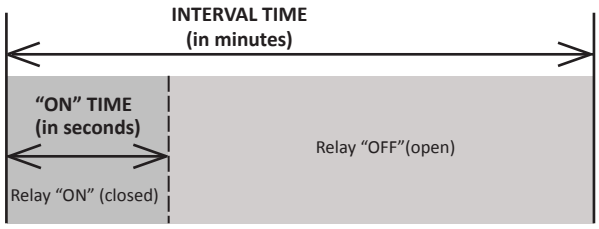

Figure 4.13

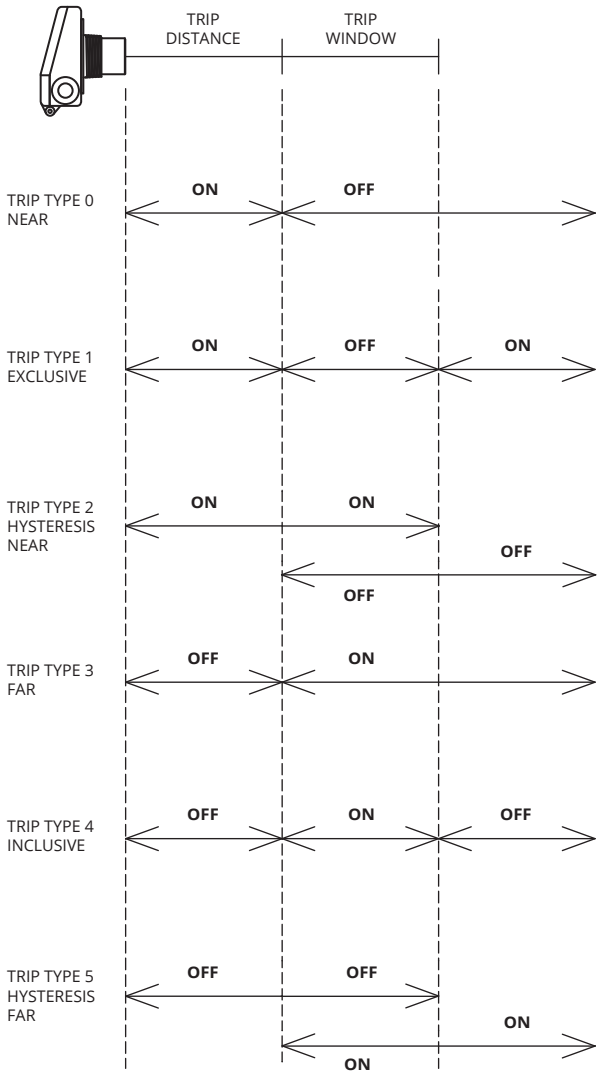

Figure 4.12

Trip Condition

9 - Abrupt Change

Abrupt Change activates the output whenever a user-defined maximum rate of level change (change in distance or level divided by elapsed time) is exceeded. *Trip Distance* defines the distance and *Trip Window* defines the time.

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External Website Communication Status

▶ Retry Time	30 to 180 Seconds	30
▶ Remote Call in Time	1 to 86400 Seconds	60
▶ Remote Bytes	8 or 160	8

Figure 4.14

The LOE embedded web server includes one parameter and two status reports for communication with the remote APG-provided website (i.e., www.levelandflow.com).

PARAMETER	**RANGE**
Retry Time	30 - 180 Seconds

Retry Time sets the time delay (in seconds) between attempts by the LOE to contact the external website.

DISPLAY	**RANGE**
Remote Call in Time	1 - 86400 Seconds

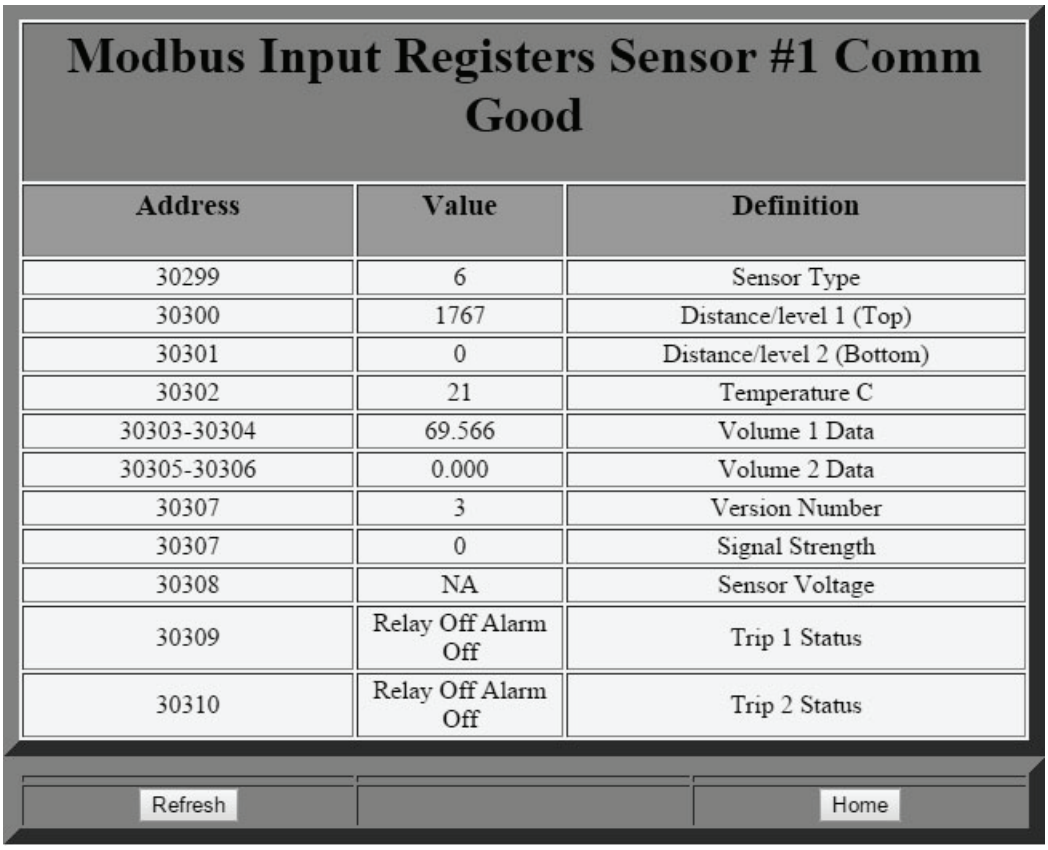
Remote Call in Time displays the duration of the last communication between the LOE and the external website.

DISPLAY	**RANGE**
Remote Bytes	8 or 160 Bytes

Remote Bytes displays the number of bytes of data sent in the last communication between the LOE and the external website. 8 bytes indicates a normal, successful transmission. 160 bytes indicates an error occured in the transmission.

- **Modbus Sensor Configuration Registers**

RS-485 Modbus Input Registers



Modbus Input Registers Sensor #1 Comm Good

Address	Value	Definition
30299	6	Sensor Type
30300	1767	Distance/level 1 (Top)
30301	0	Distance/level 2 (Bottom)
30302	21	Temperature C
30303-30304	69.566	Volume 1 Data
30305-30306	0.000	Volume 2 Data
30307	3	Version Number
30307	0	Signal Strength
30308	NA	Sensor Voltage
30309	Relay Off Alarm Off	Trip 1 Status
30310	Relay Off Alarm Off	Trip 2 Status

Refresh Home

Figure 4.15

This display-only menu shows the contents of the Input Registers for the selected Modbus sensor (See Figure 2.8). Registers used vary by sensor type. Please see the user manual for each sensor for a full list of registers.

- Detected Sensor Type Number and Sensor Model Number List:

Sensor Type	Model Number	Sensor Type	Model Number
0	LOE-2126	9	PT-400/PT-500-L31 (Level)
1	LOE-6126	10	PT-400/PT-500-L5 (Pressure)
2	LOE-3136	11	DCR-1006A
3	LOE-7126	12	LPD
4	RST-5001	13	MND
5	MPX-E1/R1 (2 floats)	14	RST-5003/4
6	MPX-E1/R1 (1 float)	15	AUS-7123
7	PG-7	16	MTM-1000
8	PG-10		

Note: This list represents sensors that interface with various APG Modbus software packages. Not all interface with the LOE.

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RS-485 Modbus Holding 1

MODBUS Holding Registers 1 Sensor #1 Comm Good

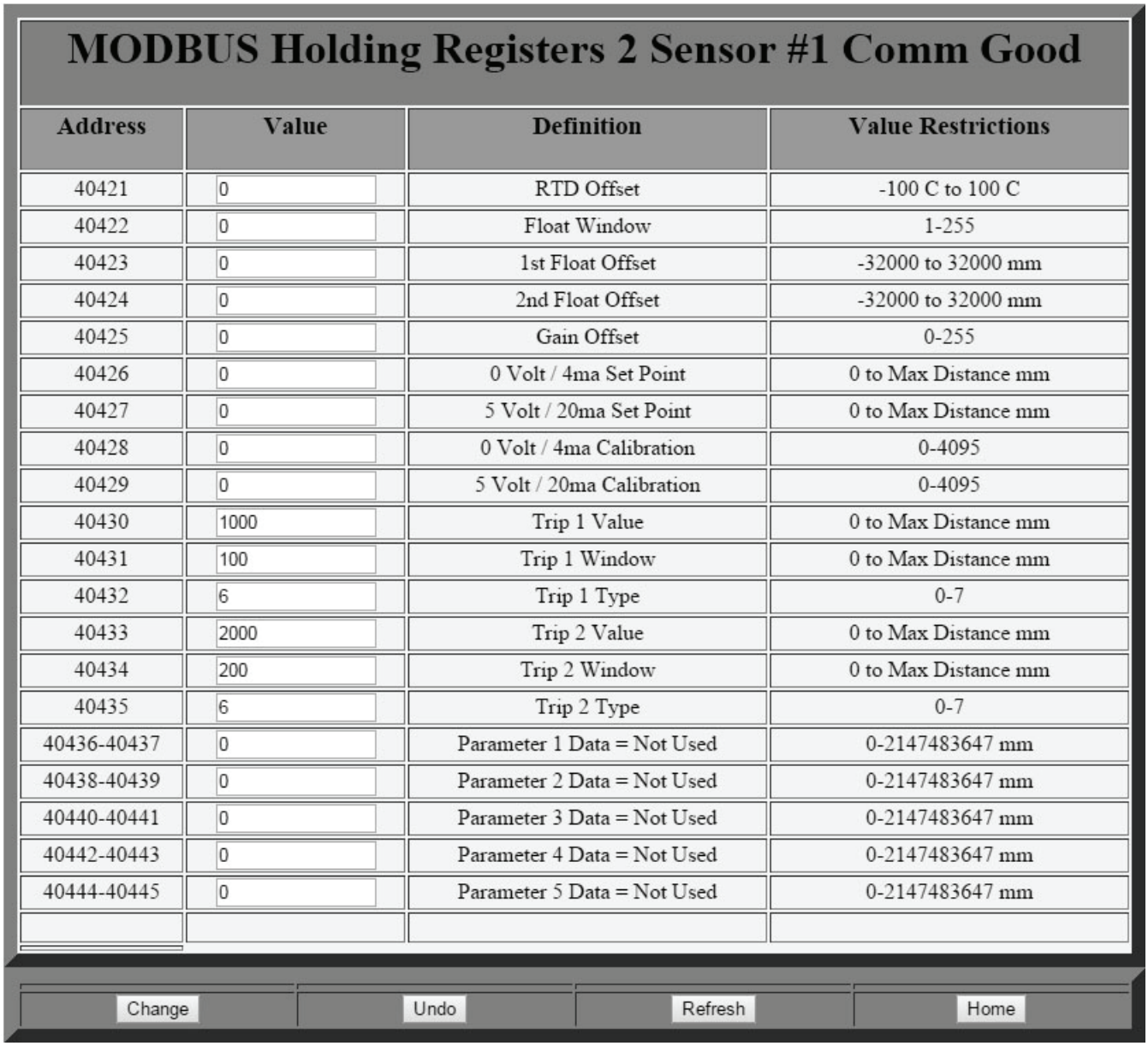
Address	Value	Definition	Value Restrictions
40401	2	Units	1=Feet 2=Inches 3=Meters
40402	0	Application Type = Distance	0=Distance 1=Level 2-7,9-11=Volume
40403	3	Volume Units = Gallons	1-7
40404	3	Decimal Place	0-3
40405	7620	Max Distance	0 to Max Distance mm
40406	304	Full Distance	0 to Max Distance mm
40407	2500	Empty Distance	0 to Max Distance mm
40408	100	Sensitivity	0-100
40409	20	Pulses	0-20
40410	300	Blanking	0 to Max Distance mm
40411	0	Gain Control	0-4
40412	2	Averaging / Response Time	0-20
40413	150	Filter Window	0 to Max Distance mm
40414	2	Out Of Range	0-255
40415	200	Sample Rate	10-1000
40416	1.011	Multiplier (Calibration)	0-1.999
40417	-10	Offset	-32000 to 32000 mm
40418	0	Fail Safe	0-2
40419	15	Fail Safe Delay	15-9999
40420	1	Temperature Compensation	0-1

Change | Undo | Refresh | Home

Figure 4.16

This menu shows the contents of the first set of Holding Registers for the selected Modbus sensor (See Figure 2.8). The register names and value restrictions are automatically configured for the type of sensor detected (See Figure 4.15). Because register name and use varies by sensor, including a full breakdown of the registers in this manual would be counterproductive. Please see the user manual for each sensor for a full list of registers.

RS-485 Modbus Holding 2



MODBUS Holding Registers 2 Sensor #1 Comm Good

Address	Value	Definition	Value Restrictions
40421	0	RTD Offset	-100 C to 100 C
40422	0	Float Window	1-255
40423	0	1st Float Offset	-32000 to 32000 mm
40424	0	2nd Float Offset	-32000 to 32000 mm
40425	0	Gain Offset	0-255
40426	0	0 Volt / 4ma Set Point	0 to Max Distance mm
40427	0	5 Volt / 20ma Set Point	0 to Max Distance mm
40428	0	0 Volt / 4ma Calibration	0-4095
40429	0	5 Volt / 20ma Calibration	0-4095
40430	1000	Trip 1 Value	0 to Max Distance mm
40431	100	Trip 1 Window	0 to Max Distance mm
40432	6	Trip 1 Type	0-7
40433	2000	Trip 2 Value	0 to Max Distance mm
40434	200	Trip 2 Window	0 to Max Distance mm
40435	6	Trip 2 Type	0-7
40436-40437	0	Parameter 1 Data = Not Used	0-2147483647 mm
40438-40439	0	Parameter 2 Data = Not Used	0-2147483647 mm
40440-40441	0	Parameter 3 Data = Not Used	0-2147483647 mm
40442-40443	0	Parameter 4 Data = Not Used	0-2147483647 mm
40444-40445	0	Parameter 5 Data = Not Used	0-2147483647 mm

Figure 4.17

This menu shows the contents of the second set of Holding Registers for the selected Modbus sensor (See Figure 2.8). The register names and value restrictions are automatically configured for the type of sensor detected (See Figure 4.15). Because register name and use varies by sensor, including a full breakdown of the registers in this manual would be counterproductive. Please see the user manual for each sensor for a full list of registers.

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- **LOE Utilty Menus**

Network Settings

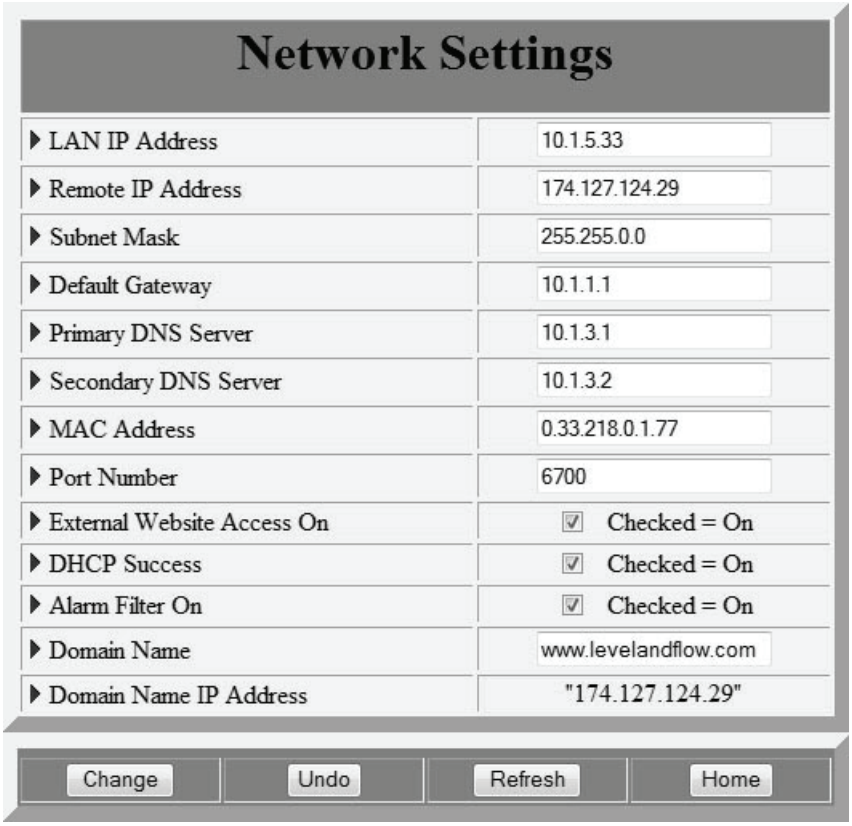

Figure 4.18

The Network Settings are provided for advanced users only and should not normally require changes. Each LOE ships with the DHCP enabled, which means it will automatically connect to the the APG-provided remote website (usually www.levelandflow.com) and configure its own Network Settings when plugged into a port providing direct internet access.

Security Settings

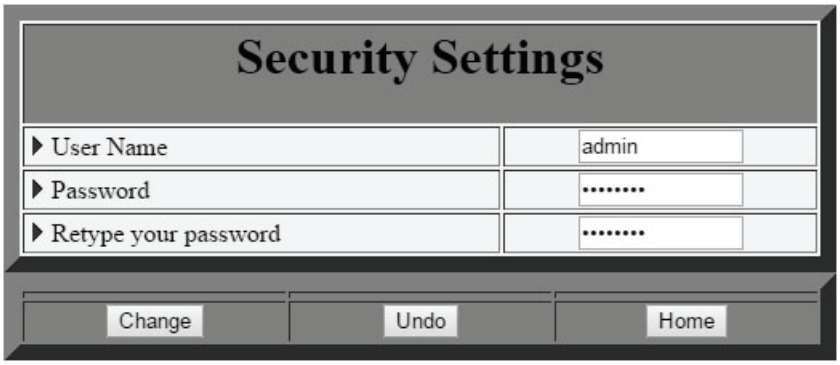

Figure 4.19

The Security Settings allow users to set their own user name and password for logging into the embedded webpage.

Labels

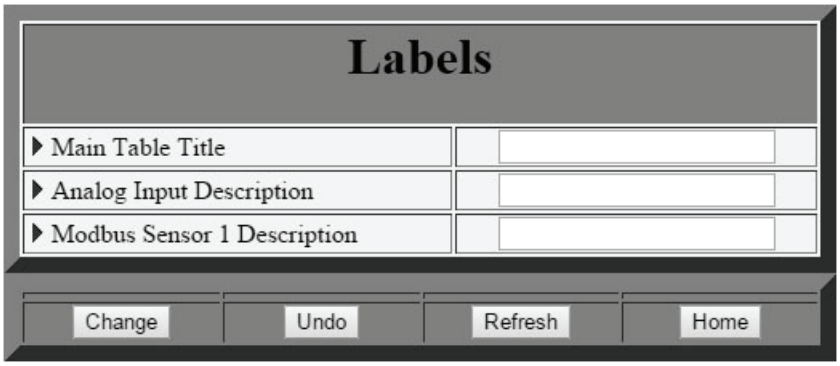

Figure 4.20

The Labels menu allow users to create custom labels for the Main Menu, the LOE, and the sensors attached to the LOE. The “Analog Input Description” is for the LOE itself.

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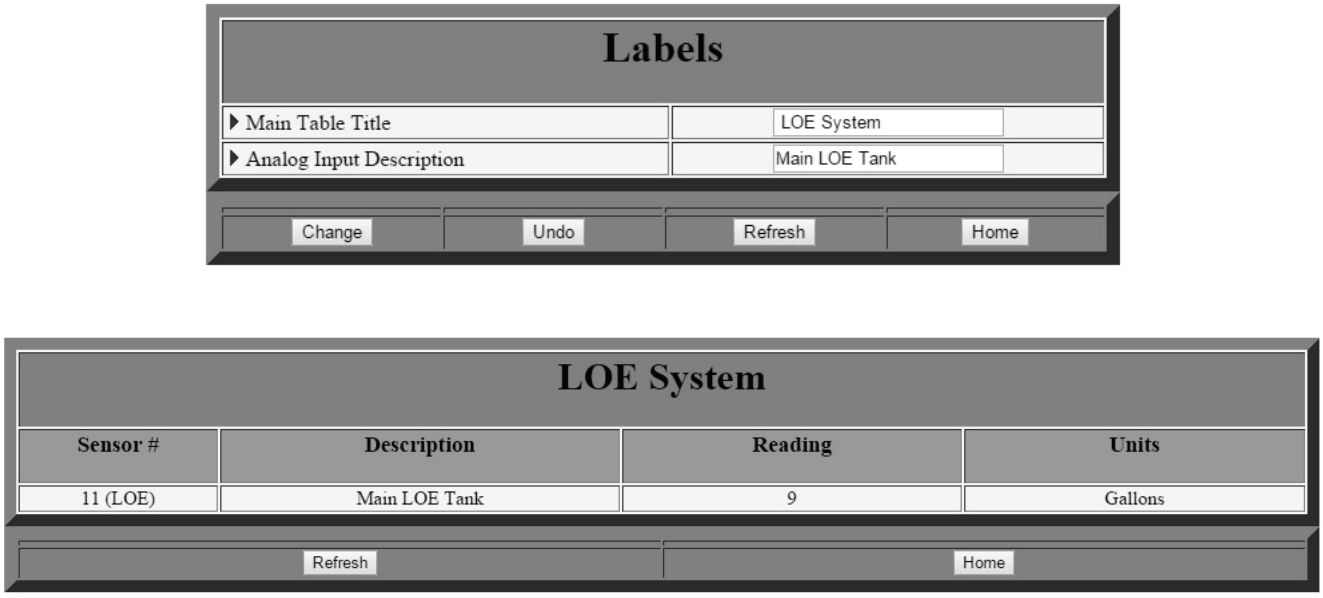


Labels

Main Table Title	LOE System
Analog Input Description	Main LOE Tank

Change | Undo | Refresh | Home

LOE System

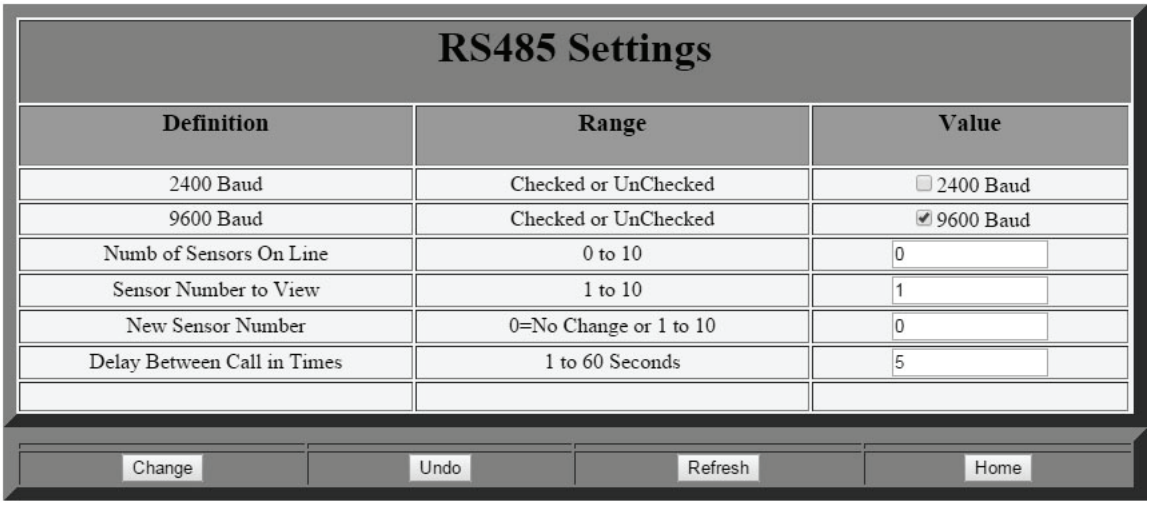
Sensor #	Description	Reading	Units
11 (LOE)	Main LOE Tank	9	Gallons

Refresh | Home

Figure 4.21

When labels are created in the Labels menu, they will be reflected on the Main Menu page (See Figure 4.21).

RS-485 Network Settings



RS485 Settings

Definition	Range	Value
2400 Baud	Checked or UnChecked	☐ 2400 Baud
9600 Baud	Checked or UnChecked	☑ 9600 Baud
Numb of Sensors On Line	0 to 10	0
Sensor Number to View	1 to 10	1
New Sensor Number	0=No Change or 1 to 10	0
Delay Between Call in Times	1 to 60 Seconds	5

Change | Undo | Refresh | Home

Figure 4.22

The RS-485 (Modbus) Settings menu controls the settings for the Modbus sensors (up to 10) attached to the LOE.

PARAMETER	RANGE
Baud Rate Checkboxes	2400 Baud 9600 Baud

Baud Rate Checkboxes are used to select the baud rate of the of the sensors connected to the LOE. All APG Modbus sensors communicate at 9600 Baud.

PARAMETER	RANGE
Numb of Sensors On Line	0 - 10

Numb of Sensors On Line sets the number Modbus sensors connected to the LOE. This setting is not automatically populated or updated. The user must change the setting manually. *Numb of Sensors On Line* must always be equal or greater than the number of actual sensors attached to the LOE.

NOTE: For best results, set Numb of Sensors On Line to the highest number of number of sensor TO BE connected. No further adjustments will be needed as those sensors are connected to the LOE.

PARAMETER	RANGE
Sensor Number to View	1 - 10

Sensor Number to View selects number of the sensor for the LOE to poll for populating the Main Menu and for editing parameters in the Modbus Holding Register menus.

PARAMETER	RANGE
New Sensor Number	0 = No Change 1 - 10

New Sensor Number changes the sensor number assigned to the sensor selected by *Sensor Number to View*.

IMPORTANT: When "Change" is pressed to assign a new sensor number, *Sensor Number to View* DOES NOT update.

PARAMETER	RANGE
RS485 Sample Rate	1 - 60 Seconds

RS485 Sample Rate determines how often the LOE polls the selected Modbus sensor.

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Chapter 5: Maintenance

• General Care

Your LOE series controller is very low maintenance and will need little care as long as it is installed correctly. However, in general, you should:

- Avoid applications for which the sensor was not designed, such as extreme temperatures, contact with incompatible corrosive chemicals and fumes, or other damaging environments.
- Inspect the threads whenever you remove the sensor from duty or change its location.

• Troubleshooting

Should you have problems with your LOE, here are some troubleshooting steps.

- Check the received signal strength (See Figure 4.9). If the signal strength is low, alternately increase Pulses and Sensitivity (See Figure 4.4) until the signal strength improves.
- Ensure Temperature Compensation (See Figure 4.4) is On (set to 1).
- Set the Gain Control to AutoSense (See Figure 4.4).
- Ensure that Blanking (See Figure 4.4) is accurately set to account for any unwanted targets between the sensor and the closest acceptable target (See Figures 4.5 - 4.7).

• Calibration

This procedure uses targets at known distances to calibrate the LOE sensor's accuracy. A wall or other large, flat object is recommended for the long range target.

- Point the sensor at a target at a known distance near the maximum range of the sensor (See Figure 5.1).
- Adjust the Multiplier value until the distance reading on the sensor matches the actual measured distance to the target (See Figure 4.4).
- Point the sensor at a target near the minimum measurement range, 1' plus any Blanking distance (See Figure 5.2).
- Adjust the Offset value until the distance reading on the sensor matches the actual measured distance to the target (See Figure 4.4).
- Repeat previous two steps until no further adjustment is required.

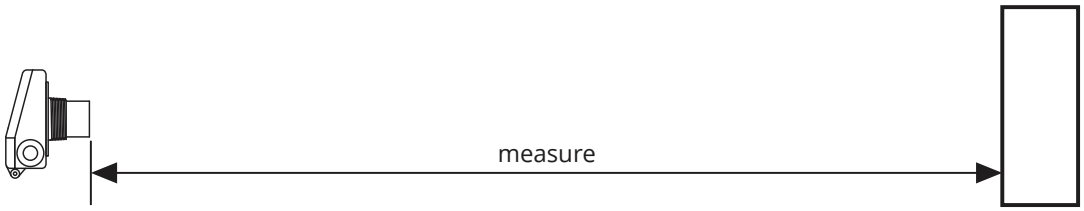

Figure 5.1

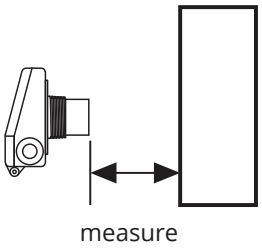

Figure 5.2

• Repair and Returns

Should your LOE require service, please contact the factory via phone, email, or online chat. We will issue you a Return Material Authorization (RMA) number with instructions.

- Phone: 888-525-7300
- Email: sales@apgsensors.com
- Online chat at www.apgsensors.com

Please have your LOE's part number and serial number available. See Warranty and Warranty Restrictions for more information.

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